UNDERGRADUATE ENGINEERING PROGRAM GRADUATE OUTCOMES, PROFESSIONAL BODIES, AND LIFELONG LEARNING: BEGINNING THE PROFESSIONAL LIFELONG LEARNING JOURNEY

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ABSTRACT

Professions acknowledge the value of innovative, responsive, and responsible self-directed workforces. In establishing students as reflective independent learners, university programs for undergraduates need to engage their students in intellectual enquiry and personal development, and to commence the process of developing their lifelong learning mindsets while furnishing them with mechanisms by which to do so. In accrediting undergraduate engineering programs, professional bodies seek to measure how effective a university's mechanisms are in producing engineers for the future. They do this by determining how competencies to achieve graduate attributes are developed, monitored, and assessed over the period of study.

INTRODUCTION

For the past ten years or so the engineering profession in Australia has been engaged in a self-reflective and critical analysis of what it means to be an engineer. In doing so, members of the profession have commenced the process of reinventing themselves and transforming themselves from a profession that previously had a heavy focus upon technical skills and knowledge – at the expense of generic skills – to a profession that understands and celebrates the need for an appropriate balance of technical and generic skills.

Over this time, members of the engineering fraternity at Central Queensland University have consulted widely with industry and engaged in dialogue with the professional body, Engineers Australia. These consultations have served to inform and confirm the fraternity's interpretation of the trends in engineering education. Through such deliberations they acknowledge that the information age or the time of the "'knowledge' worker is definitely upon us, where people need flexible and transferable skills, not least of which is the ability to continue learning all through their lives" (Institute of Management, 1996, p. 20). Furthermore, a fundamental premise of the group when designing curriculum has been that students need to take responsibility for their learning. This correlates well with ideas of Boud and Lublin (1983) that education needs to provide the "growth of a student's ability to be realistic judges of their own performance and the ability to monitor their own learning."

Becoming a lifelong learner involves discipline, initiative, resourcefulness, and an evolving knowledge of self. Parkinson (1999) believes that universities need to foster an engineering student's desire to become a lifelong learner. In particular, Parkinson (1999) considers the key attributes for students to become lifelong learners involves them taking responsibility for their learning, managing their education effectively, employing active methods of learning, engaging in design projects, engaging in research, taking up opportunities to learn outside the classroom, and performing self-assessment. These aspects have been incorporated and adopted as a means by which to benchmark the progressive development of the programs. Harvey (2001, as cited in Holden and Harte, 2004) argues that the "critical purpose of higher education is not so much the delivery of employability skills in some generic sense but the development of 'critical lifelong learners' (p. 274).

ATTRIBUTES OF A LIFELONG LEARNER

The Commission of the European Communities (2000) believes that "lifelong learning sees all learning as a seamless continuum 'from cradle to grave'" (p. 7). While there is no one definition for lifelong learning, the Commission of the European Communities (2000) puts its description into perspective when it highlights that any definition of lifelong learning is "largely informal and pragmatic, wedded more closely to action than to conceptual clarity or legal terms" (p. 9). It is in this context that we will define a skill set to help students become lifelong learners. These skills are derived from Laver (1995), Parkinson (1999), and Candy (2000) and include the ability of students to (a) work in a team, (b) take responsibility for their

learning, (c) engage in self appraisal and reflective practice, and (d) exercise critical thinking.

The ability to work in a team requires "behavioural and managerial processes that are exhibited, such as security and protection; affiliation; esteem and identity; task achievement; member roles and status; group cohesiveness; norms; conflict resolution; negotiation; team work; communication" (Vecchio, 1995). Team work allows students to become more confident in their responses and completion of tasks because they are able to express their ideas and opinions; especially when they observe that others can make mistakes like themselves, and while also in a supportive learning environment created by the lecturer or larger group. A successful group also accommodates a spectrum of teaching, learning, and studying styles.

In order for students to take responsibility for their learning Briedis (1998) advocates the need for "proactive strategies that engineering programs may use to jump start interest and appreciation for lifelong learning in students". A lifelong learner has an intrinsic sense of the joy of learning and a desire to develop to the best of his or her potential. To achieve this goal students can exercise self-assessment and reflective practice whereby they ascertain their strengths and weaknesses and then determine strategies to address the weaknesses. Students engaging in critical thinking are required to develop an attitude of suspended judgment that incorporates logical enquiry and problem solving, with this ultimately leading to an evaluative decision or action.

Interestingly, Parkinson (1999) highlights the example of great scientists and engineers as inspirations for lifelong learning. He does this by using critical appraisal to gain an understanding of how these people developed the range of skills that enabled them to conceptualise, devise, and overcome diversity and set backs to make their remarkable achievements. They are categorized as being powerful lifelong learning role models.

PROGRAMS DEVELOPMENT

The philosophy of our programs has been to improve learning experiences by making assessments of practice in more authentic circumstances. A focus upon students developing and demonstrating their problem-solving skills, communication strategies, reflective practices, and group-working abilities to complete concrete, practical, and complex tasks is achieved through industry placement. This fits well with Munch and Jakobsen (2005) notions of providing students with experiences of a dynamic curriculum through the "envisioning [of] user contexts, situations, networks, etc. – ie. focusing on competencies" (p. 2). They go on to highlight the "concept of competence as essentially dealing with practice" (p. 2), which precipitates the "unfolding of knowledge, skills and abilities in a concrete practical setting" (p. 2). Thus they subscribe to Boshuisen and Schmidt's (1992) assertion that competence is always "competence-in-practice".

This paper concentrates on engineering programs offered by the faculty since 1990. The programs offered from 1990-1997 are deemed as the "old programs", those from 1998-2006 are deemed as the "current programs", and the programs to be introduced from 2007 are described as being the "forthcoming programs".

The National Review of Engineering Education (1996) gave impetus to the faculty to meet the accreditation requirements of the Institute of Engineers - Australia. While the current faculty programs, which were introduced in 1998, were developed in parallel with the review, the outcomes of an industry-CQU liaison pre-empted the outcomes of the National Review. Consequently, this demonstrated that CQU Engineering was in tune with the future of professional practice. When the new graduate attributes were published by the Institute of Engineers - Australia (1999) the faculty adopted them in their entirety as the graduate attributes for our programs because they correlated well with our understanding and reflected our thinking and discussions with industry and the profession.

As highlighted in Jorgensen and Howard (2005) the faculty conducted a review, in 1996, of the Bachelor of Engineering program in an endeavour to specifically address particular issues. These included

- concerns articulated by employers in general that engineering graduates were not being properly prepared for the modern workforce,
- graduates were deemed to be specifically lacking generic skills such as problem solving, creativity, communication and teamwork,

- assertions that the program was overloaded with technical content, and contact hours (e.g., 29 hours of weekly contact),
- 100 percent employment of graduates, but no guarantee that the program was delivering what employers needed,
- high attrition rates, especially from the first year of the program were too high (up to 50 percent),
- students have little motivation or enthusiasm for their study with a further three years of "grind" in front of them,
- "tick-a-box" perception of the degree that students were acquiring,
- rare requirement to integrate or utilise material until students graduated and became employed,
- style of student learning was shallow and superficial – apparently minimal retention or understanding,
- course material was taught in isolation and rarely in context,
- vacation work (8 – 10 weeks time period) did not give students or employers enough time to have the students fit in and take on a role of importance,
- little opportunity for students to apply any of their academic learning in the workplace prior to graduation.

It is recognised that the life cycle of our programs is reflected in the following type of timeframes: Design: two years; implementation: with first graduates 4½ years later; monitoring and implementation of improvements (including feedback from graduates, employers, professional body): a further 4½ years – until all existing students are graduated (i.e., nine years until any major review can be implemented). The conduction of a formal full review can be undertaken towards the end of the study of the ninth year cohort. This constitutes eleven years in total and explains why even though the National Review was conducted in 1996, we are still referring to its recommendations. Consequently, since 2005 the faculty has been conducting a major review as part of the continuous improvement process.

In the old programs, lifelong learning as a concept was not specifically addressed. However, the current programs sought to actively embed lifelong learning aspects into the learning experiences of students. While one of the ten Institute of Engineers - Australia (1999) graduate attributes was "expectation of the need to undertake lifelong learning, and capacity to do so" there was no provisions about how this was to be achieved. The faculty chose to achieve this innovatively through the delivery mode of Project Based Learning (PBL).

PBL exposes students to real-life experiences. It does this by using ill-structured, open-ended problems that the students are to solve as part of a team. In finding the solution, students must identify what they know, what they do not know, and what they need to know. They then must use self-directed learning along with structured learning experiences to develop skills and knowledge to solve the problem. This strategy is supported by Wood (1994) "… the key for PBL is that the focus is to use a problem situation to drive the learning activities on a need-to-know-basis" (p. 22).

The use of PBL develops a repertoire of skills that include lifelong learning skills. However, these were not made explicit at the course level so that students appreciate and are able to articulate their learning and knowledge of them.

The use of PBL met Institute of Engineers - Australia (1999) requirements for the lifelong learning graduate attribute but the faculty was aware that these skills were not being explicitly assessed. One of the strategies within the current review of programs to develop the forthcoming programs is a mapping of the developmental progress of a student, in regard to skills and knowledge, against the learning outcomes of individual courses in order to achieve the graduate attributes. This acknowledges the need to explicitly define, state, and articulate them to the student, and to indicate how they are to be assessed. The current assessment method in all PBL courses is a portfolio. The portfolio requires students to demonstrate how and to what level they have met the learning objectives of the course. At this stage it is envisaged that this assessment method will continue in the forthcoming programs. For lifelong learning skills to be made explicit they will need to become learning objectives that students can articulate, and the achievement of which they can demonstrate.

CREATING LIFELONG LEARNING CAPACITY

Parkinson (1999) proposes that a key principle in developing a lifelong learning mindset in undergraduate students is that it is imperative for universities to help students become lifelong learners by having them "assume responsibility

for their education while at the university". As indicated, our forthcoming programs will be designed to explicitly incorporate learning objectives to develop and assess a student's capacity to be a lifelong learner. However, our current programs have been successful, through team-based PBL, in providing learning experiences that facilitate lifelong learning skills.

Boud (as cited in Greenan, Humphreys, and McIlveen (1997) contends that self-appraisal and peer assessment is, "fundamental to all aspects of learning", and argues that the development of a reflective student – one who would be considered to have a degree of self-directed independence – is well placed to become a lifelong learner. Consequently, this signifies the need for students to participate in a more active role in successfully managing their own learning, as well as meeting the needs of the industrial market place for adaptable, creative thinkers who can transfer their learning methodology and cope with new situations in the workplace. In our courses the portfolios require each student to assess themselves.

The manner in which self-appraisal occurs differs between the courses in our programs and is undertaken through a developmental approach. This is a deliberate learning strategy which enables students to have a progressive understanding of the facets involved in undertaking self-appraisement. For example, first-year students are guided in the process of assessing themselves against a set of standard criteria. In later years they are required to develop their own criteria; the purpose being that it becomes a process which supports deeper self-reflection.

Every PBL course requires students to keep a personal reflective journal. This journal is to show the learning journey. Whereas a diary would merely report facts or occurrences, the journal requires the students to document experiences they have had, both in and out of the classroom, and how these experiences have impacted on their understanding and knowledge of the course. This also relates to themselves and how they have dealt with the situations, and through their review of past entries they are able to gain an appreciation of their personal growth. The aim of this activity is not for the students to become better writers but for reflective practice to become second nature for them, and for it to be part of their repertoire of skills as rounded professionals.

Portfolios are a device used to demonstrate the manner in which students take responsibility for their learning. This is achieved through the requirements of the portfolio: that students must demonstrate how and to what level they have met each of the learning objectives of the course. There is no set format or specific questions. This process makes students articulate what they know and how they know it. Thus students demonstrate that they know how to learn when they are able to articulate what they know and how they know it. They can do this by explaining what they have done in the projects and what they have accomplished, with descriptions and explanations about the decisions they made at various points. In particularly, they are able to report on the mistakes they have made and the manner in which to avoid such mistakes or how to overcome them. It can also be done by discussing self-directed learning activities; for instance, critiquing readings or reporting on discussions with an industry representative. While doing their learning, in a team, a portfolio allows students to be assessed as individuals. This alleviates the issue of student's experiencing the inequity of obtaining a team mark as an individual. It also allows them the freedom to make mistakes and to learn from their mistakes without being "right" and also dependent upon their team members for either increasing or decreasing their overall mark if based on a team result. In using a portfolio there is no reliance upon any single assessment item. However, the program review process has provided the opportunity to challenge and provide discussion about diversifying assessment processes so that staff and students are more conversant of the range of options open to them.

Critical thinking skills, like the skills of lifelong learning, have a multiplicity of definitions. One aspect that we focus upon is evaluating the thinking process. In particular the reasoning that students used to make the decisions that they did and the factors that they considered in making that decision. Within their portfolio, students demonstrate their level of achievement by being required to justify their decisions. For the current generation of students great reliance is placed upon electronic sources of information such as the world wide web and databases. In choosing, evaluating, and appreciating the inherent bias and ambiguities of information sources, students need to use critical thinking to determine such porperties as accuracy and currency. The way in which the learning

experiences are designed, and the manner in which students are assessed in our programs, highlights how students develop their critical thinking skills. Students are able to demonstrate critical thinking skills by identifying the specific problem to be solved from the ill-structured problem; identifying the processes to solve the problem; and their ability to identify the tools, skills, and knowledge they require.

Our forthcoming programs will also offer students the option to undertake their study through flexible delivery mode. As a mode of learning, the Deakin Centre for Academic Development (as cited in Palmer (2001, p2), explains that "flexible teaching and learning … refers to an approach to education design and conduct based on the conviction that education is a recurrent, lifelong process, centred in the learner and the learner's ability to make choices about the way learning occurs."

CONCLUSION

CQU's engineering programs have a teaching and learning philosophy specifically designed to address lifelong learning. They are supported by Engineers Australia who designate lifelong learning as one of the ten graduate attributes required for an engineering program to be accredited. The faculty does believe that we are achieving it, but this belief is based upon anecdotal evidence. To address the next accreditation round we will have to demonstrate how we actively promote, deliver, and assess lifelong learning capabilities and parameters. The current review of the programs is highlighting how this is to be addressed.

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